Claims:

1. An optical switch, comprising:

at least one input port for receiving a plurality of channel wavelengths of an optical signal and a plurality of output ports; and

a plurality of wavelength selective elements that each select a channel wavelength from among the plurality of channel wavelengths received at the at least one input port;

a plurality of optical elements respectively associated with said plurality of wavelength selective elements, each of said optical elements directing one of the selected channel wavelengths selected by the associated wavelength selective element to any one of the output ports independently of all other channel wavelengths and with a selectively variable degree of attenuation; and

a controller for adjusting a configuration of the optical elements to provide the channel wavelengths with the selectively variable degree of attenuation.

2. The optical switch of claim 1 further comprising a monitoring arrangement for determining a power level of a given channel wavelength received in the at least one input port relative to a power level of said given channel wavelength received in one of the output ports.

3. The optical switch of claim 1 further comprising a monitoring arrangement for determining respective power levels of the plurality of channel wavelengths received in the at least one input port relative to respective power levels of the plurality of channel wavelengths received in the output ports.

4. The optical switch of claim 2 wherein said monitoring arrangement comprises:

at least one monitoring port receiving a portion of optical power at each of the channel wavelengths from the at least one input port;

at least one detector associated with at least one of said wavelength selective elements for measuring a power level of an optical signal incident thereon, said detector

being positioned to receive from the monitoring port the portion of optical power at the channel wavelength selected by the associated wavelength selective element .

5. The optical switch of claim 3 further comprising a plurality of input ports and wherein said monitoring arrangement comprises:

a plurality of monitoring ports each receiving a portion of optical power at each of the channel wavelengths from one of the input ports;

a plurality of detectors each associated with one of the plurality of wavelength selective elements for measuring a power level of an optical signal incident thereon, said detectors being positioned to respectively receive from the monitoring port the portion of optical power at the channel wavelength selected by the associated wavelength selective element.

6. The optical switch of claim 4 wherein said optical elements each include a collimating lens and a tiltable mirror.

7. The optical switch of claim 5 wherein said optical elements each include a collimating lens and a tiltable mirror.

8. The optical switch of claim 6 wherein said detector is positioned so that said received portion of the given channel wavelength does not traverse said collimating lens.

9. The optical switch of claim 7 wherein said detectors are positioned so that the portion of the selected channel wavelengths received from the monitoring ports does not traverse said collimating lens.

10. The optical switch of claim 1 wherein said configuration of the optical elements adjusted by the controller is a position of the optical elements.

11. The optical switch of claim 6 wherein said configuration of the optical elements adjusted by the controller is a position of the tiltable mirror.

12. The optical switch of claim 1 wherein at least one of the optical elements includes a shutter for attenuating the selected channel wavelength directed by the optical element, and wherein said configuration of the optical elements adjusted by the controller includes a position of the shutter within a path traversed by the selected channel wavelength.

13. The optical switch of claim 1 further comprising a free space region disposed between the input ports and the output ports.

14. The optical switch of claim 4 further comprising a free space region disposed between the input ports and the wavelength selective elements.

15. The optical switch of claim 1 wherein said optical elements retroreflect said channel wavelengths.

16. The optical switch of claim 4 wherein said wavelength selective elements are thin film filters each transmitting therethrough a different one of the channel wavelengths and reflecting the remaining channel wavelengths.

17. The optical switch of claim 4 wherein said optical elements are reflective mirrors that are selectively tiltable in a plurality of positions such that in each of the positions the mirrors reflect the channel wavelength incident thereon to any selected one of the output ports.

18. The optical switch of claim 1 wherein the configuration of the optical elements adjusted by the controller includes a position of the optical elements.

19. The optical switch of claim 17 wherein the configuration of the optical elements adjusted by the controller includes the position of the reflective mirrors.

20. The optical switch of claim 17 wherein said reflective mirrors are part of a micro-electromechanical (MEM) retroreflective mirror assembly.

21. The optical switch of claim 17 wherein said reflective mirrors are part of a retroreflective optical assembly.

22. The optical switch of claim 17 wherein said reflective mirrors each include a piezoelectric actuator.

23. The optical switch of claim 14 wherein said free space region comprises an optically transparent substrate having first and second parallel surfaces, said wavelength selective element includes a plurality of wavelength selective elements arranged in first and second arrays extending along the first and second parallel surfaces, respectively.

24. The optical switch of claim 23 wherein the optically transparent substrate includes air as a medium in which the optical signal propagates.

25. The optical switch of claim 23 where the optically transparent substrate is silica glass.

26. The optical switch of claim 23 wherein said first and second arrays are laterally offset with respect to one another.

27. The optical switch of claim 26 wherein each of said wavelength selective elements arranged in the first array direct the selected channel wavelength to another of said wavelength selective elements arranged in the second array.

28. The optical switch of claim 4 further comprising a collimating lens disposed between each one of said wavelength selective elements and the optical element associated therewith, each of said optical elements being positioned at a focal point of the lens associated therewith.

29. The optical switch of claim 28 wherein said collimating lens and said optical element serve as a retroreflector.

30. An optical amplifier system for amplifying with a prescribed gain at least one channel wavelength of a WDM optical signal, said optical amplifier arrangement comprising:

an optical amplifier having an input port and an output port;

a dynamic gain adjuster, said dynamic gain adjuster including:

at least one input port for receiving the WDM optical signal and at least one output port, said output port of the dynamic gain adjuster being optically coupled to the input port of the optical amplifier;

a plurality of wavelength selective elements that each select a channel wavelength from among the channel wavelengths received at the input port of the dynamic gain adjuster;

a plurality of optical elements respectively associated with said plurality of wavelength selective elements, each of said optical elements directing one of the selected channel wavelengths selected by the associated wavelength selective element to said output port of the dynamic gain adjuster with a selectively variable degree of attenuation and independently of all other channel wavelengths; and

a controller for adjusting a configuration of at least one of the optical elements to provide the channel wavelength directed by the optical element with the selectively variable degree of attenuation to achieve the prescribed gain at the output port of the optical amplifier.

31. The optical amplifier system of claim 30 further comprising a second optical amplifier having an output coupled to the input port of the dynamic gain adjuster.

32. The optical amplifier system of claim 30 wherein the controller adjusts a configuration of each of the plurality of optical elements to provide the channel wavelengths respectively directed by the plurality of optical elements with a selectively

variable degree of attenuation to achieve the prescribed gain at the output port of the optical amplifier.

33. The optical amplifier system of claim 30 further comprising a monitoring arrangement for determining a power level of a first channel wavelength in said input port relative to a power level of the first channel wavelength at the output port of the optical amplifier.

34. The optical amplifier system of claim 33 wherein said monitoring arrangement includes at least first and second monitoring ports respectively receiving a portion of a channel wavelength from the input port of the dynamic gain equalizer and from the output port of the optical amplifier;

35. A WDM optical communication system, comprising:

a plurality of network nodes, each of said nodes including an optical switch;

at least one optical communication link interconnecting said nodes;

at least one gain adjustable optical amplifier arrangement located along the communication link, said gain adjustable optical amplifier arrangement including:

an optical amplifier having an input port and an output port;

a dynamic gain adjuster, said dynamic gain adjuster including:

at least one input port for receiving the WDM optical signal and at least one output port, said output port of the dynamic gain adjuster being optically coupled to the input port of the optical amplifier;

a plurality of wavelength selective elements that each select a channel wavelength from among the channel wavelengths received at the input port of the dynamic gain adjuster;

a plurality of optical elements respectively associated with said plurality of wavelength selective elements, each of said optical elements directing one of the selected channel wavelengths selected by the associated wavelength selective element to said output port of the dynamic

gain adjuster with a selectively variable degree of attenuation and independently of all other channel wavelengths; and

a controller for adjusting a configuration of at least one of the optical elements to provide the channel wavelength directed by the optical element with the selectively variable degree of attenuation to achieve the prescribed gain at the output port of the optical amplifier.

36. An optical amplifier system for amplifying with a prescribed gain at least one channel wavelength of a WDM optical signal, said optical amplifier arrangement comprising:

an optical amplifier having an input port and an output port;

a dynamic gain adjuster, said dynamic gain adjuster including:

at least one input port for receiving the WDM optical signal and at least one output port, said input port of the dynamic gain adjuster being optically coupled to the output port of the optical amplifier;

a plurality of wavelength selective elements that each select a channel wavelength from among the channel wavelengths received at the input port of the dynamic gain adjuster;

a plurality of optical elements respectively associated with said plurality of wavelength selective elements, each of said optical elements directing one of the selected channel wavelengths selected by the associated wavelength selective element to said output port of the dynamic gain adjuster with a selectively variable degree of attenuation and independently of all other channel wavelengths; and

a controller for adjusting a configuration of at least one of the optical elements to provide the channel wavelength directed by the optical element with the selectively variable degree of attenuation to achieve the prescribed gain at the output port of the dynamic gain adjuster.

37. The optical amplifier system of claim 36 wherein the controller adjusts a configuration of each of the plurality of optical elements to provide the channel wavelengths respectively directed by the plurality of optical elements with a selectively

variable degree of attenuation to achieve the prescribed gain at the output port of the dynamic gain adjuster.

38. The optical amplifier system of claim 36 further comprising a monitoring arrangement for determining a power level of a first channel wavelength at the input port of the optical amplifier relative to a power level of the first channel wavelength at the output port of the dynamic gain adjuster.

39. The optical amplifier system of claim 38 wherein said monitoring arrangement includes at least first and second monitoring ports respectively receiving a portion of a channel wavelength from the output port of the dynamic gain equalizer and from the input port of the optical amplifier;

40. A method for directing at least first and second wavelength components of a WDM signal that includes a plurality of wavelength components from an input port to selected ones of a plurality of output ports, said method comprising the steps of:

(a) demultiplexing the first wavelength component from the WDM signal;

(b) directing the first wavelength component to a given output port while selectively attenuating the first wavelength component;

(c) demultiplexing the second wavelength component from the WDM signal; and

(d) directing the second wavelength component to one of the output ports selected independently from the given output port to which the first wavelength component is directed

41. The method of claim 40 further comprising the step of selectively attenuating the second wavelength component while performing step (d).

42. The method of claim 40 further comprising, while performing step (d), the step of selectively attenuating the second wavelength component by a different amount of attenuation than is imparted to the first wavelength component.

43. The method of claim 40 further comprising the steps of monitoring a power level of the first wavelength component before and after selectively attenuating the first wavelength component.

44. The method of claim 40 wherein step (d) is performed subsequent to step (c).

45. The method of claim 40 wherein the first and second wavelength components travel substantially different path lengths between the input port and the output port to which they are respectively directed.

46. The method of claim 40 wherein the steps of directing the first and second wavelength components includes the steps of directing the first and second wavelength components through a free space region.

47. The method of claim 40 wherein the first wavelength is demultiplexed by a thin film filter having a passband corresponding to the first wavelength.

48. The method of claim 46 wherein the first wavelength component is directed through the free space region by a tiltable mirror.

49. The method of claim 48 wherein the step of directing the first wavelength component to a given output port while selectively attenuating the first wavelength component includes the step of adjusting a position of the tiltable mirror.

50. The method of claim 48 wherein the tiltable mirror is a MEM mirror.